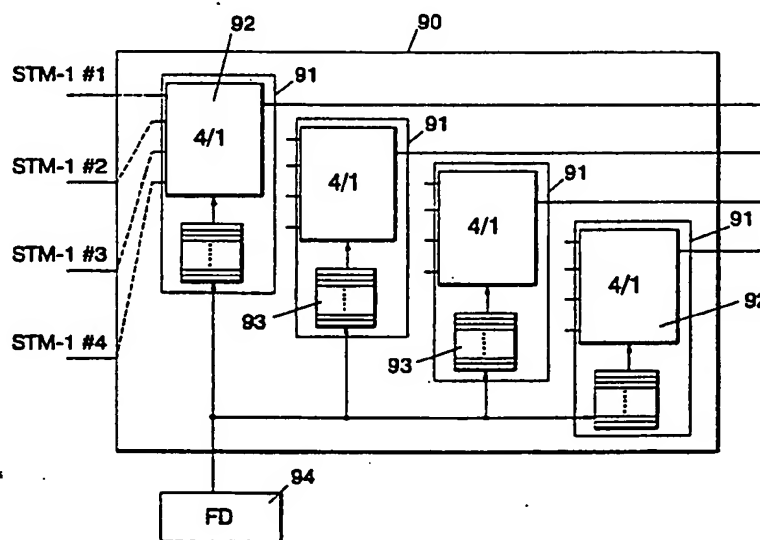




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁵ : H04Q 11/04, 11/08		A1	(11) International Publication Number: WO 94/03021
			(43) International Publication Date: 3 February 1994 (03.02.94)
(21) International Application Number: PCT/FI93/00292 (22) International Filing Date: 8 July 1993 (08.07.93) (30) Priority data: 923297 17 July 1992 (17.07.92) FI (71) Applicant (for all designated States except US): NOKIA TELECOMMUNICATIONS OY [FI/FI]; Mäkkylän puistotie 1, FIN-02600 Espoo (FI). (72) Inventors; and (75) Inventors/Applicants (for US only) : ALATALO, Hannu [FI/FI]; Kirkkokatu 79-81 A 9, FIN-90120 Oulu (FI). KOKKO, Marko [FI/FI]; Taidonkaari 8 A 9, FIN-90570 Oulu (FI).		(74) Agent: OY KOLSTER AB; Stora Robertsgatan 23, P.O. Box 148, FIN-00121 Helsinki (FI). (81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published With international search report.	

(54) Title: METHOD FOR IMPLEMENTING SWITCHING IN TIME OR SPACE DOMAIN



(57) Abstract

The invention relates to a method for implementing switching in the time or space domain. In the method, the switching is effected on the basis of switching data contained in an address control memory (66; 93), and a basic switching block (42) is defined on the basis of an incoming frame structure so that the number of its time slots corresponds to the greatest possible number of signals of the lowest level of hierarchy (TU-12) to be switched in the frame, said basic switching block recurring in the same form with respect to switching. In order for the switching to be simplified (i) the number of the switching instructions to be stored in the address control memory (66; 93) corresponds to the size of the basic switching block, whereby when the basic switching block also contains higher-level signals, the same switching instruction is used in the address control memory (66; 93) at given intervals, depending on how said signals occur in the basic switching block, and (ii) the same address control memory (66; 93) is read during the entire frame structure, whereby it gives a switching instruction to all time slots in the frame, and (iii) the switching instructions read from the address control memory (66; 93) are skipped during the time slots which are not cross-connected.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	MR	Mauritania
AU	Australia	GA	Gabon	MW	Malawi
BB	Barbados	GB	United Kingdom	NE	Niger
BE	Belgium	GN	Guinea	NL	Netherlands
BF	Burkina Faso	GR	Greece	NO	Norway
BG	Bulgaria	HU	Hungary	NZ	New Zealand
BJ	Benin	IE	Ireland	PL	Poland
BR	Brazil	IT	Italy	PT	Portugal
BY	Belarus	JP	Japan	RO	Romania
CA	Canada	KP	Democratic People's Republic of Korea	RU	Russian Federation
CF	Central African Republic	KR	Republic of Korea	SD	Sudan
CG	Congo	KZ	Kazakhstan	SE	Sweden
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovak Republic
CM	Cameroon	LU	Luxembourg	SN	Senegal
CN	China	LV	Latvia	TD	Chad
CS	Czechoslovakia	MC	Monaco	TG	Togo
CZ	Czech Republic	MG	Madagascar	UA	Ukraine
DE	Germany	ML	Mali	US	United States of America
DK	Denmark	MN	Mongolia	UZ	Uzbekistan
ES	Spain			VN	Viet Nam
FI	Finland				

Method for implementing switching in time or space domain

5 The invention relates to a method according to the preamble of the accompanying claim 1 for implementing switching in the time domain, and to a method according to the preamble of the accompanying claim 3 for implementing switching in the space domain, for signals of several different levels of hierarchy, said
10 signals having a common frame structure. An example of such a frame structure is the frame structure of an STM-1 signal used in the SDH system; this frame structure will be illustrated in greater detail below.

15 The method of the invention can thus be used in both time and space switches. In this connection, time switch refers to a device capable of switching the contents of any time slot in the frame structure of an incoming signal to any time slot in an outgoing frame structure (switching in time). In addition to a time
20 switch, this device can also be called a time slot interchanger. Space switch, in turn, refers to a switch capable of connecting any incoming line to any outgoing line (switching in space).

25 In known switching methods, the switching of e.g. the tributary unit groups (TU-12, TU-2, TU-3) of an STM-1 frame is implemented by giving switching instructions separately to 3, 21 or 63 columns by starting the switching from column 13 on TU-3 level and from column 19 on TU-2 and TU-12 levels. It has thus been
30 possible to effect the switching on one level at a time. Another way has been to switch columns 19 to 270 in blocks of 63 columns, and to give switching instructions separately to columns 13 to 18 on TU-3 level. In this way it has been possible to effect cross-connection on
35 all the three levels at the same time.

The drawback of the known switching methods is, however, that they entail fairly complicated practical equipment.

5 The object of the present invention is to remedy the drawback described above. This is achieved with a method of the invention, which, as regards time switching, is characterized by what is disclosed in the characterizing part of the accompanying claim 1 and, as regards space switching, by what is disclosed in the characterizing part of the accompanying claim 3.

10 The idea of the invention is to utilize the frame structure of an incoming signal by defining a basic switching block, which recurs in the frame structure in the same form from the point of view of switching, and to effect the switching of all time slots merely on the basis of an address control memory intended for the switching of said basic switching block by reading said memory cyclically, and by skipping the switching instructions at the time slots which are not cross-connected.

15 Owing to the solution of the invention, it is not necessary to inform the actual switch about the level of the signals to be cross-connected. The solution allows thus the practical equipment to be implemented in a more simplified manner than before.

20 In the following the invention will be described in more detail with reference to the examples which are based on an STM-1 signal and illustrated in the attached drawings, in which

25 Figure 1 shows the basic structure of a single STM-N frame,

Figure 2 shows the structure of a single STM-1 frame,

30 Figure 3 shows the assembly of the STM-N frame from existing PCM systems,

Figure 4 shows an STM-1 frame and blocks of different sizes contained in it,

Figure 5 shows a time switch and implementation of time switching according to the invention,

5 Figure 6 is a more detailed view of the read unit of the time switch shown in Figure 5, and

10 Figure 7 shows how the switching instructions of the address control memory in the time switch of the invention are distributed to the different channels in three separate cases,

15 Figure 8 shows how the switching instructions of the address control memory in the time switch of the invention are distributed to the channels of different levels of hierarchy in a case where signals of three different levels of hierarchy are switched simultaneously, and

Figure 9 shows a solution of the invention as applied to a space switch.

20 Figure 1 illustrates the structure of an STM-N frame used in the SDH network, and Figure 2 illustrates a single STM-1 frame. The STM-N frame comprises a matrix with 9 rows and $N \times 270$ columns so that there is one byte at the junction point between each row and the column. Rows 1-3 and rows 5-9 of the $N \times 9$ first columns
25 comprise a section overhead SOH, and row 4 comprises an AU pointer. The rest of the frame structure is formed of a section having the length of $N \times 261$ columns and containing the payload section of the STM-N frame.

30 Figure 2 illustrates a single STM-1 frame which is 270 bytes in length, as described above. The payload section comprises one or more administration units AU. In the example shown in the figure, the payload section consists of the administration unit AU-4, into which a highest-level virtual container VC-4 is inserted.
35 (Alternatively, the STM-1 transfer frame may contain

three AU-3 units, each containing a corresponding lower-level virtual container VC-3). The VC-4 in turn consists of a path overhead POH located at the beginning of each row and having the length of one byte (9 bytes altogether), fixed stuff FS located at the following two columns, TU-3 pointers or a null pointer indicator NPI located at the following three columns, fixed stuff or VC-3 path overheads (VC-3 POH) located at the following three columns, and the actual payload section PL. The null pointer indicator NPI is used to separate the tributary unit groups TUG-3 comprising TU-3 units from the tributary unit groups TUG-3 comprising TU-2 units.

Figure 3 shows how the STM-N frame can be formed of existing bit streams. These bit streams (1.5, 2, 6, 8, 34, 45 or 140 Mbit/s, shown on the right in the figure) are packed at the first stage into containers C specified by CCITT. At the second stage, overhead bytes containing control data are inserted into the containers, thus obtaining the above-described virtual container VC-11, VC-12, VC-2, VC-3 or VC-4 (the first suffix in the abbreviations represents the level of hierarchy and the second suffix represents the bit rate). This virtual container remains intact while it passes through the synchronous network up to its point of delivery. Depending on the level of hierarchy, the virtual containers are further formed either into so-called tributary units TU or into AU units (AU-3 and AU-4) already mentioned above by providing them with pointers. The AU unit can be mapped directly into the STM-1 frame, whereas the TU units have to be assembled through tributary unit groups TUG and VC-3 and VC-4 units to form AU units which then can be mapped into the STM-1 frame. In Figure 3, the mapping is indicated by a continuous thin line, the aligning with a broken line, and the multiplexing with a continuous thicker line.

As is to be seen from Figure 3, the STM-1 frame may be assembled in a number of alternative ways, and the contents of the highest-level virtual container VC-4, for instance, may vary, depending on the level from which the assembly has been started and in which way the assembly has been performed. The STM-1 signal may thus contain e.g. 3 TU-3 units or 21 TU-2 units or 63 TU-12 units (or an arbitrary combination of some of the above-mentioned units). As the higher-level unit contains several lower-level units, e.g. the VC-4 unit contains TU-12 units (there are 63 such units in a single VC-4 unit, cf. Figure 3), the lower-level units are mapped into the higher-level frame by interleaving so that the first bytes are first taken consecutively from each one of the lower-level units, then the second bytes, etc. Accordingly, when the VC-4 signal contains e.g. the above-mentioned 63 TU-12 signals, these signals are located in the VC-4 frame as shown in Figure 2, i.e. the first byte of the first TU-12 signal is located first, then the first byte of the second TU-12 signal, etc. After the first byte of the last signal, i.e. the 63rd TU-12 signal, the second byte of the first TU-12 signal follows, etc.

The following table shows the contents of the columns of the STM-1 frame as a summary, depending on whether the frame contains TU-12, TU-2 or TU-3 units.

Column, Number	TU-12	TU-2	TU-3
1-9	SOH	SOH	SOH
10	VC-4 POH	VC-4 POH	VC-4 POH

11-12	fixed stuff	fixed stuff	fixed stuff
13-15	NPI	NPI	TU-3 pointers
16-18	fixed stuff	fixed stuff	VC-3 POH
19-81	1x63xTU-12	3x21xTU-2	21x3xTU-3
82-144	1x63xTU-12	3x21xTU-2	21x3xTU-3
145-207	1x63xTU-12	3x21xTU-2	21x3xTU-3
208-270	1x63xTU-12	3x21xTU-2	21x3xTU-3

The SDH system is described more closely e.g. in References [1] to [3] (the references are listed at the end of the specification).

On the basis of the above, the frame of the STM-1 signal can be illustrated with respect to the switching as shown in Figure 4. It consists of blocks of two types: e.g. the first 18 bytes, consisting of section and path overheads, on each row form the first block 41, and the following 63 bytes on each row form the second block 42, of which there are four successive ones in a single STM-1 frame 4. The data contained in the first block is not cross-connected (except for columns 13 to 18 in the case of TU-3 signals), but it continues in the same time slots even in the outgoing frame.

Figures 5 and 6 show the solution of the invention in connection with time switching. Figure 5 is a block diagram illustrating the structure of the time switch, and Figure 6 is a more detailed view of the read unit 63 shown in Figure 5. The time switch shown in this example is the object of copending Finnish Patent Applications No. 923295 and 923296 with the same filing date as the present application. However, the method of the

invention can also be used in conventional time switches.

5 The time switch (Figure 5) comprises only one memory block 61, which is twice as large as the largest frame block. In this case the size of the memory block 61 is thus 126 bytes. Writing into the memory is controlled by a simple counter 62, which is not in synchronization with the incoming signal frame (but is in synchronization with the clock signal), and which counts
10 continuously from 1 to 126. The bytes of an incoming signal containing frame blocks of different sizes are written continuously into the memory at the address WA given by the counter, said address being incremented by one for each byte. The writing is effected without synchronization with the incoming signal frame, i.e. starting from an arbitrary location in the frame.
15

The write address WA given by the counter 62 is also supplied to a read unit 63, more specifically to a subtractor circuit 64 therein (Figure 6), which
20 generates the delay by subtracting the value 63 from the write address (in this case the cross-connection delay has the length of 63 bytes, and in general it is as long as the duration of the largest frame block in bytes). The read address thus obtained is supplied to an adder circuit 65, which adds the read address to the switching data obtained from the address control memory 66.
25

The above-described basic structure of the STM-1 frame allows TU-2/3 signals to be switched as if they were made of TU-12 signals. This can be done by defining
30 63 consecutive bytes of the STM-1 frame as a basic switching block. Since all of these blocks (columns 19-81, 82-144, 145-207 and 208-270 in the STM-1 frame) are switched in the same manner, it is not necessary to define more than one switching matrix for them. The
35 address control memory has thus the length of 63 memory

locations, it is read cyclically in the manner described above, and it gives cross-connection data to each time slot of said blocks so that each TU-12 channel has its own switching instruction, or each TU-2 channel has three similar switching instructions, or each TU-3 channel has 21 similar switching instructions.

In this example a relative read address is used as the switching data in the address control memory. This means that the switching data at each memory location in the address control memory indicates the relative transition of the data contained in the time slot within the frame structure. The relative address is positive if the signal leaves the time switch in a relatively earlier time slot than it came in, and negative in the opposite case. A relative address can have (integer) values between -62 and +62, but not, however, in every time slot; each time slot has its own acceptable range within which the relative read address can be. The first time slot of each row of each frame block 42 can thus have only positive address values (from 0 to +62), the second time slot can have address values from -1 to +61, etc., and the last time slot can have only negative values and zero, i.e. address values from 0 to -62 (all of the above-mentioned lowest and highest values included). The use of the relative read address is described more closely in the above-mentioned Finnish Patent Application, which is referred to for a more detailed description.

As the multiplexing of tributary unit groups of different levels of hierarchy is based on byte interleaving, columns 19, 22, 25...268 form the first TU-3 unit, columns 20, 23, 26...269 form the second TU-3 unit, and columns 21, 24, 27...270 form the third TU-3 unit, or correspondingly the first, second and third TUG-3 unit, which contains TU-2 and/or TU-12 units (cf.

Figure 3). So, for example, switching instruction words (memory locations) 1, 4, 7, 10, 13...61 give the switching instruction to the first TU-3 channel, instruction words 2, 5, 8, 11, 14...62 give it to the second TU-3 channel, and instruction words 3, 6, 9, 12, 15...63 give it to the third TU-3 channel. Figure 7 illustrates how the switching instruction words (memory locations) of the address control memory are connected with the different channels in cases where the STM-1 frame contains (i) only TU-12 units, (ii) only TU-2 units, and (iii) only TU-3 units.

The address control memory receives information on the phase of the frame from an output 67a of a phase identification circuit 67. A column flag CFLG, which provides information on when columns 1 to 12 are in progress in the frame, is obtained from another output 67b of the phase identification circuit 67. When this flag is valid (during these columns), the output of the address control memory is forced to become zero, i.e. during these columns the adder circuit 65 is not given cross-connection data. On account of the relative address zero, the data in said columns passes "straight" through the switch (i.e. leaves the switch in the same time slot as it came in). The output of the adder circuit 65 has thus the value (WA-63), whereas each time slot of the blocks 42 has the value (WA-63 + relative read address), in which the relative read address is within a certain range depending on the time slot, as stated above. In addition, the contents of the address control memory must be interpreted at columns 13 to 18 (cf. the above table); i.e. it must be verified whether the switching instruction is reasonable. If other columns than columns 13 to 15 are addressed during these columns, the instruction is not reasonable, and a column relating to any TU-3 signal cannot be concerned. The

same applies to columns 16 to 18 as well. If the switching instruction is not reasonable, the null pointer indicator NPI is generated into columns 13 to 15, and correspondingly fixed stuff into columns 16 to 18. If the instruction is a reasonable TU-3 level switching instruction, it may be part of a TU-3 or TU-2 switching instruction, or it may be a TU-12 switching instruction. The column in question can be switched in any case, for if a TU-2 or TU-12 signal is switched by a TU-3-type instruction, it is switched from an incoming TUG-3 unit, which in this case cannot contain a TU-3 signal. Therefore it does not matter if the location of the null pointer indicator should change.

Figure 8 shows an example of the contents of the address control memory when the basic switching block comprises a combination of signals of different levels of hierarchy (which may be of any kind, depending on how a single STM-1 frame can be assembled, cf. Figure 3). In this case, the same instruction has been copied into each TU-3 channel at intervals of three memory locations, into each TU-2 channel at intervals of 21 memory locations, and each TU-12 channels has only one switching instruction.

The solution of the invention can also be used in a space switch 90 shown in Figure 9. In the example the space switch has four inputs and four outputs. It is provided with four multiplexer units 91, each of which comprises a 4/1 multiplexer 92 and an address control memory 93. The inputs of each multiplexer 92 are connected to the corresponding input of the space switch (shown in the figure merely with respect to the first multiplexer), and the output of each multiplexer forms one of the outputs of the space switch. Each 4/1 multiplexer is controlled by a separate address control memory 93. In this case, a single address control memory

has 63 memory locations, and the switching data are grouped according to Figures 7 and 8. In this case the most preferable form of a switching instruction is, however, not the relative read address but the absolute address, i.e. the number of the incoming STM-1 signal (the number of the input line), which in this case is from 1 to 4. This number indicates the STM-1 signal the byte of which is switched at that particular moment to the output of the multiplexer. When the STM-1 frame begins, the reading of the switching instruction words is started one time slot at a time. This is continued until the instruction word 18, whereafter the process returns to the beginning, and all the 63 instruction words are read. This is effected four times, whereafter a new STM-1 frame begins. During columns 1 to 12 the switching data is always skipped, i.e. cross-connection is not performed but the data is switched straight through (the bytes of the first input are switched to the first output, the bytes of the second input to the second output, etc.). Information on the phase of the frame is received from a phase identification circuit 94. In the space switch, columns 13 to 18 need not be interpreted as in the case of the time switch, since in the space switch erroneous switching cannot be performed in the same way as in the time switch.

As the space switch is known *per se*, it will not be described here in greater detail.

Even though the invention has been described above with reference to the examples shown in the attached drawings, it is obvious that the invention is not restricted to them but may be modified in various ways within the inventive idea disclosed above and in the accompanying claims. Even though the invention has been described with reference to an SDH specific STM-1

12

signal, the solution of the invention can also be used in connection with any time division multiplex signal.

References:

- 5
- [1] CCITT Blue Book, Recommendation G.709: "Synchronous Multiplexing Structure", May 1990.
- [2] SDH - Ny digital hierarki, TELE 2/90.
- 10 [3] CCITT Blue Book, Recommendation G.783: "Characteristics of Synchronous Digital Hierarchy (SDH) Multiplexing Equipment Functional Blocks," August 1990, Annex B.

Claims:

1. A method for implementing time switching for signals of several different levels of hierarchy, said signals having a common frame structure, in which method the contents of the time slots of an incoming signal are written into a memory (61) at a memory location determined by a write address (WA) and read from said memory (61) at the memory locations indicated by switching data contained in an address control memory (66), and a basic switching block is defined on the basis of the frame structure of an incoming signal so that the number of its time slots corresponds to the greatest possible number of signals of the lowest level of hierarchy (TU-12) to be switched, said basic switching block recurring in the same form with respect to the switching, characterized in that

- the number of switching instructions to be stored in the address control memory (66) corresponds to the size of the basic switching block (42), whereby when the basic switching block also contains higher-level signals, the same switching instruction is used in the address control memory (66) at given intervals, depending on how said signals occur in the basic switching block (42), and

- the same address control memory (66) is read during the entire frame structure, whereby it gives a switching instruction to all time slots in the frame, and

- the switching instructions read from the address control memory (66) are skipped during the time slots which are not cross-connected.

2. A method according to claim 1, characterized in that the switching instruction used is a relative read address, which indicates the relative

transition of the data contained in the time slot within the frame structure, the switching instruction being forced to become zero during the time slots which are not cross-connected.

5 3. A method for implementing switching in the space domain for signals of several different levels of hierarchy, said signals having a common frame structure, in which method the switching is effected on the basis of switching data included in an address control memory (93), and a basic switching block (42) is defined on the basis of an incoming frame structure so that the number of its time slots corresponds to the greatest possible number of signals of the lowest level of hierarchy (TU-12) to be switched, said basic switching block (42) recurring in the same form with respect to switching, c h a r a c t e r i z e d in that

10 - the number of switching instructions to be stored in the address control memory (93) corresponds to the size of the basic switching block (42), whereby when the basic switching block also contains higher-level signals, the same switching instruction is used in the address control memory (93) at given intervals, depending on how said signals occur in the basic switching block (42), and

15 - the same address control memory (93) is read during the entire frame structure, whereby it gives a switching instruction to all time slots in the frame, and

20 - the switching instructions read from the address control memory (66) are skipped during the time slots which are not cross-connected.

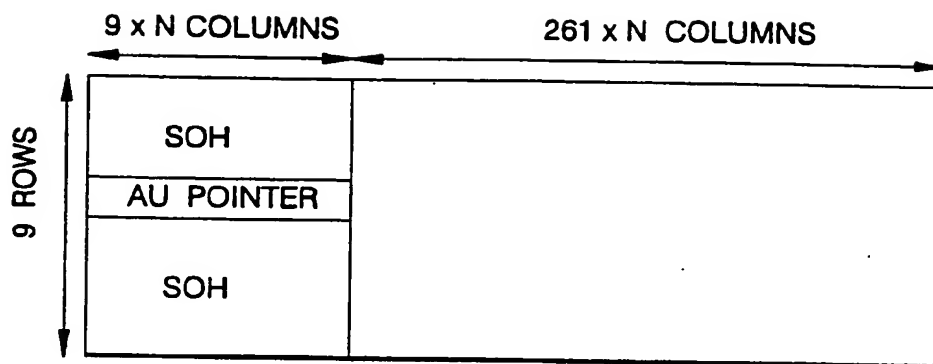


FIG. 1

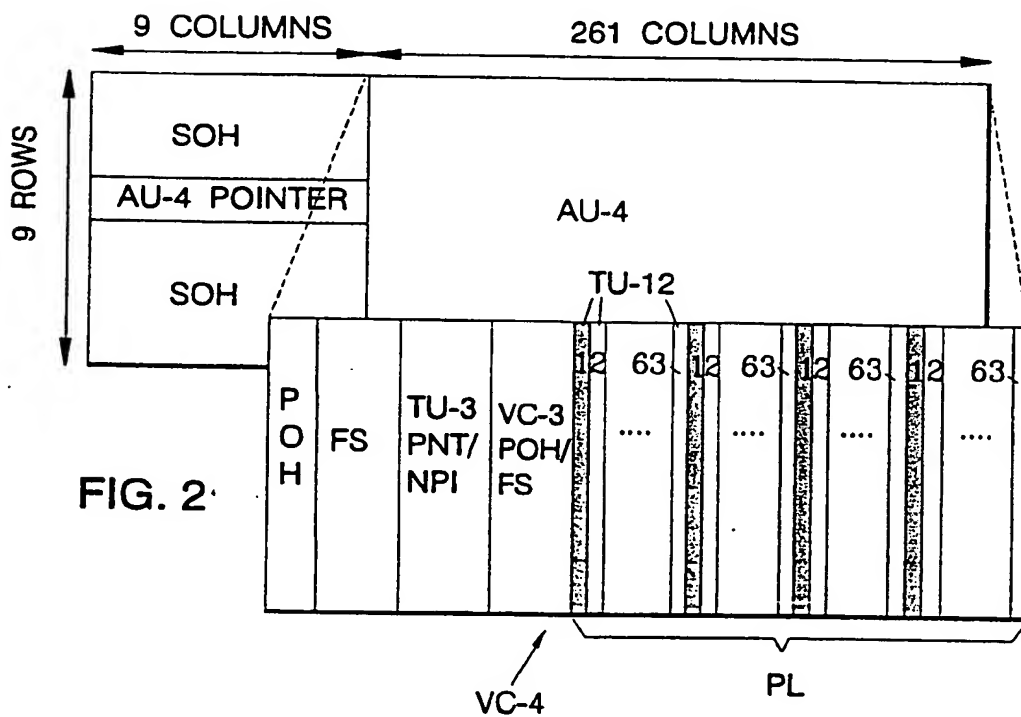


FIG. 2

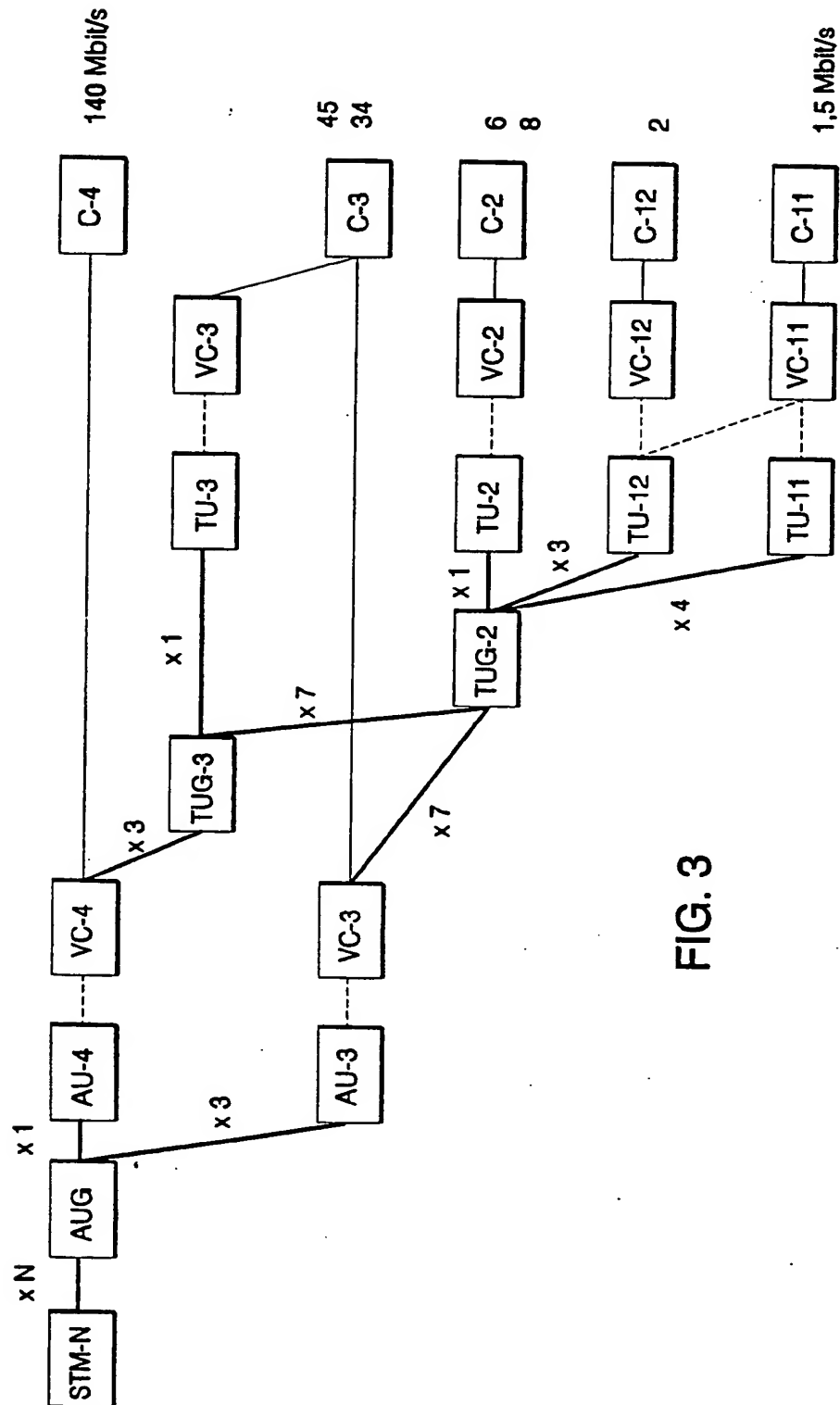


FIG. 3

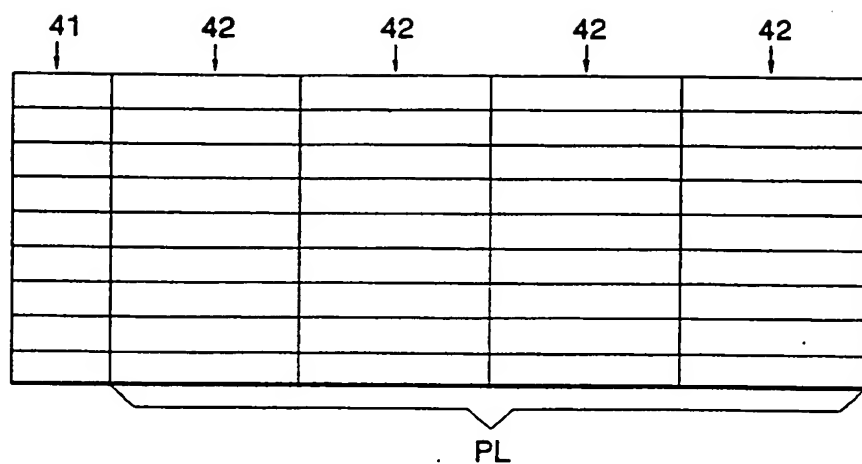


FIG. 4

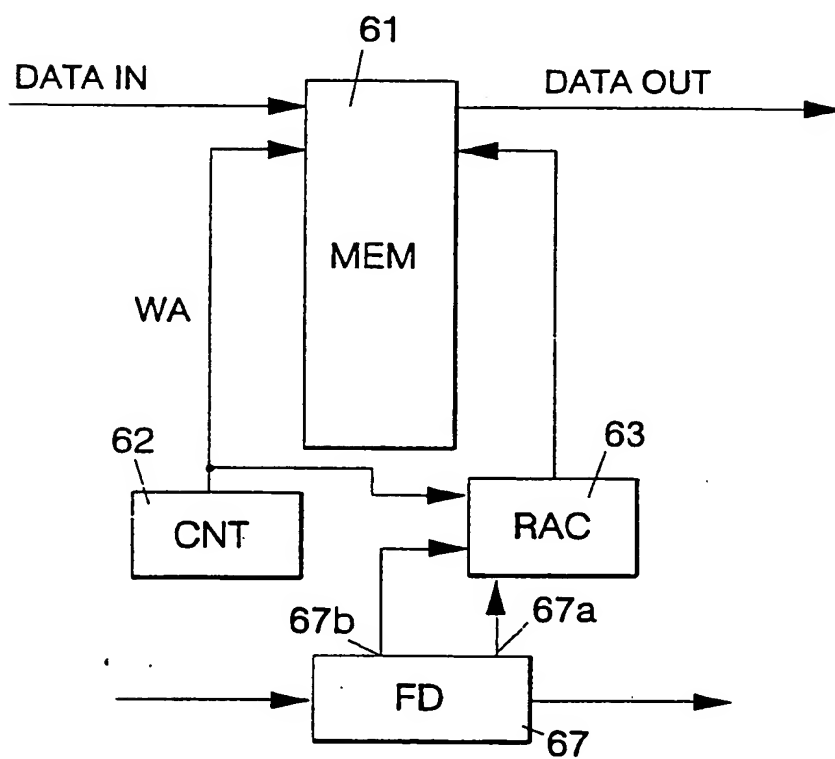


FIG. 5

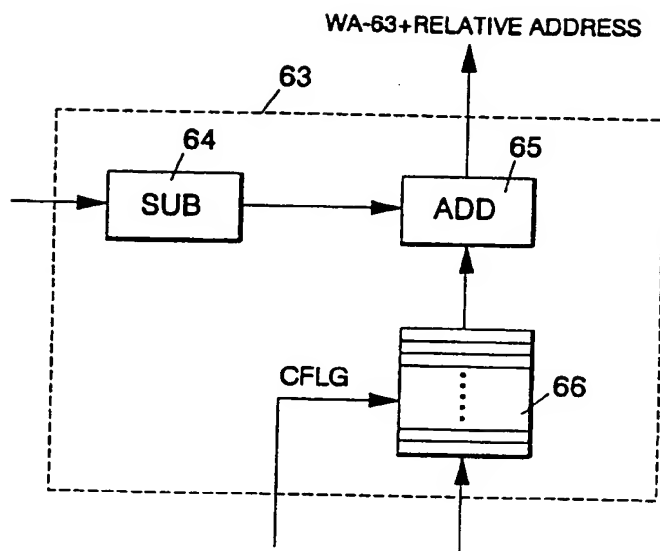


FIG. 6

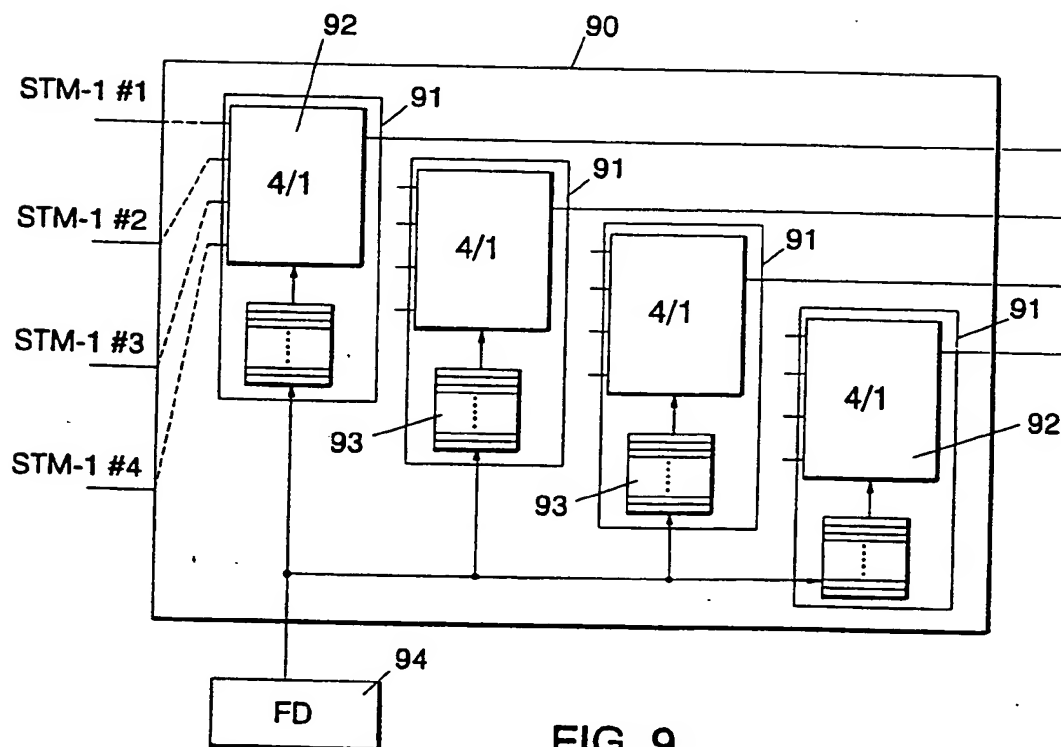


FIG. 9

INSTRUCTION WORD NO.	TU-12	TU-2	TU-3
1	SW. INSTR./ TU-12 #0	SW. INSTR./ TU-2 #0	SW. INSTR./ TU-3 #0
2	SW. INSTR./ TU-12 #1	SW. INSTR./ TU-2 #1	SW. INSTR./ TU-3 #1
3	SW. INSTR./ TU-12 #2	SW. INSTR./ TU-2 #2	SW. INSTR./ TU-3 #2
4	SW. INSTR./ TU-12 #3	SW. INSTR./ TU-2 #3	SW. INSTR./ TU-3 #0
5	SW. INSTR./ TU-12 #4	SW. INSTR./ TU-2 #4	SW. INSTR./ TU-3 #1
6	SW. INSTR./ TU-12 #5	SW. INSTR./ TU-2 #5	SW. INSTR./ TU-3 #2
7	SW. INSTR./ TU-12 #6	SW. INSTR./ TU-2 #6	SW. INSTR./ TU-3 #0
8	SW. INSTR./ TU-12 #7	SW. INSTR./ TU-2 #7	SW. INSTR./ TU-3 #1
9	SW. INSTR./ TU-12 #8	SW. INSTR./ TU-2 #8	SW. INSTR./ TU-3 #2
10	SW. INSTR./ TU-12 #9	SW. INSTR./ TU-2 #9	SW. INSTR./ TU-3 #0
11	SW. INSTR./ TU-12 #10	SW. INSTR./ TU-2 #10	SW. INSTR./ TU-3 #1
12	SW. INSTR./ TU-12 #11	SW. INSTR./ TU-2 #11	SW. INSTR./ TU-3 #2
13	SW. INSTR./ TU-12 #12	SW. INSTR./ TU-2 #12	SW. INSTR./ TU-3 #0
14	SW. INSTR./ TU-12 #13	SW. INSTR./ TU-2 #13	SW. INSTR./ TU-3 #1
15	SW. INSTR./ TU-12 #14	SW. INSTR./ TU-2 #14	SW. INSTR./ TU-3 #2
16	SW. INSTR./ TU-12 #15	SW. INSTR./ TU-2 #15	SW. INSTR./ TU-3 #0
17	SW. INSTR./ TU-12 #16	SW. INSTR./ TU-2 #16	SW. INSTR./ TU-3 #1
18	SW. INSTR./ TU-12 #17	SW. INSTR./ TU-2 #17	SW. INSTR./ TU-3 #2
19	SW. INSTR./ TU-12 #18	SW. INSTR./ TU-2 #18	SW. INSTR./ TU-3 #0
20	SW. INSTR./ TU-12 #19	SW. INSTR./ TU-2 #19	SW. INSTR./ TU-3 #1
21	SW. INSTR./ TU-12 #20	SW. INSTR./ TU-2 #20	SW. INSTR./ TU-3 #2
22	SW. INSTR./ TU-12 #21	SW. INSTR./ TU-2 #0	SW. INSTR./ TU-3 #0
23	SW. INSTR./ TU-12 #22	SW. INSTR./ TU-2 #1	SW. INSTR./ TU-3 #1
24	SW. INSTR./ TU-12 #23	SW. INSTR./ TU-2 #2	SW. INSTR./ TU-3 #2
25	SW. INSTR./ TU-12 #24	SW. INSTR./ TU-2 #3	SW. INSTR./ TU-3 #0
26	SW. INSTR./ TU-12 #25	SW. INSTR./ TU-2 #4	SW. INSTR./ TU-3 #1
27	SW. INSTR./ TU-12 #26	SW. INSTR./ TU-2 #5	SW. INSTR./ TU-3 #2
28	SW. INSTR./ TU-12 #27	SW. INSTR./ TU-2 #6	SW. INSTR./ TU-3 #0
29	SW. INSTR./ TU-12 #28	SW. INSTR./ TU-2 #7	SW. INSTR./ TU-3 #1
30	SW. INSTR./ TU-12 #29	SW. INSTR./ TU-2 #8	SW. INSTR./ TU-3 #2
31	SW. INSTR./ TU-12 #30	SW. INSTR./ TU-2 #9	SW. INSTR./ TU-3 #0
32	SW. INSTR./ TU-12 #31	SW. INSTR./ TU-2 #10	SW. INSTR./ TU-3 #1
33	SW. INSTR./ TU-12 #32	SW. INSTR./ TU-2 #11	SW. INSTR./ TU-3 #2
34	SW. INSTR./ TU-12 #33	SW. INSTR./ TU-2 #12	SW. INSTR./ TU-3 #0
35	SW. INSTR./ TU-12 #34	SW. INSTR./ TU-2 #13	SW. INSTR./ TU-3 #1
36	SW. INSTR./ TU-12 #35	SW. INSTR./ TU-2 #14	SW. INSTR./ TU-3 #2
37	SW. INSTR./ TU-12 #36	SW. INSTR./ TU-2 #15	SW. INSTR./ TU-3 #0
38	SW. INSTR./ TU-12 #37	SW. INSTR./ TU-2 #16	SW. INSTR./ TU-3 #1
39	SW. INSTR./ TU-12 #38	SW. INSTR./ TU-2 #17	SW. INSTR./ TU-3 #2
40	SW. INSTR./ TU-12 #39	SW. INSTR./ TU-2 #18	SW. INSTR./ TU-3 #0
41	SW. INSTR./ TU-12 #40	SW. INSTR./ TU-2 #19	SW. INSTR./ TU-3 #1
42	SW. INSTR./ TU-12 #41	SW. INSTR./ TU-2 #20	SW. INSTR./ TU-3 #2
43	SW. INSTR./ TU-12 #42	SW. INSTR./ TU-2 #0	SW. INSTR./ TU-3 #0
44	SW. INSTR./ TU-12 #43	SW. INSTR./ TU-2 #1	SW. INSTR./ TU-3 #1
45	SW. INSTR./ TU-12 #44	SW. INSTR./ TU-2 #2	SW. INSTR./ TU-3 #2
46	SW. INSTR./ TU-12 #45	SW. INSTR./ TU-2 #3	SW. INSTR./ TU-3 #0
47	SW. INSTR./ TU-12 #46	SW. INSTR./ TU-2 #4	SW. INSTR./ TU-3 #1
48	SW. INSTR./ TU-12 #47	SW. INSTR./ TU-2 #5	SW. INSTR./ TU-3 #2
49	SW. INSTR./ TU-12 #48	SW. INSTR./ TU-2 #6	SW. INSTR./ TU-3 #0
50	SW. INSTR./ TU-12 #49	SW. INSTR./ TU-2 #7	SW. INSTR./ TU-3 #1
51	SW. INSTR./ TU-12 #50	SW. INSTR./ TU-2 #8	SW. INSTR./ TU-3 #2
52	SW. INSTR./ TU-12 #51	SW. INSTR./ TU-2 #9	SW. INSTR./ TU-3 #0
53	SW. INSTR./ TU-12 #52	SW. INSTR./ TU-2 #10	SW. INSTR./ TU-3 #1
54	SW. INSTR./ TU-12 #53	SW. INSTR./ TU-2 #11	SW. INSTR./ TU-3 #2
55	SW. INSTR./ TU-12 #54	SW. INSTR./ TU-2 #12	SW. INSTR./ TU-3 #0
56	SW. INSTR./ TU-12 #55	SW. INSTR./ TU-2 #13	SW. INSTR./ TU-3 #1
57	SW. INSTR./ TU-12 #56	SW. INSTR./ TU-2 #14	SW. INSTR./ TU-3 #2
58	SW. INSTR./ TU-12 #57	SW. INSTR./ TU-2 #15	SW. INSTR./ TU-3 #0
59	SW. INSTR./ TU-12 #58	SW. INSTR./ TU-2 #16	SW. INSTR./ TU-3 #1
60	SW. INSTR./ TU-12 #59	SW. INSTR./ TU-2 #17	SW. INSTR./ TU-3 #2
61	SW. INSTR./ TU-12 #60	SW. INSTR./ TU-2 #18	SW. INSTR./ TU-3 #0
62	SW. INSTR./ TU-12 #61	SW. INSTR./ TU-2 #19	SW. INSTR./ TU-3 #1
63	SW. INSTR./ TU-12 #62	SW. INSTR./ TU-2 #20	SW. INSTR./ TU-3 #2

SW.INSTR. = Switching instruction

FIG. 7

6/6

INSTRUCTION WORD
NO.

TU-12-2/-3

1	SW. INSTR./ TU-3 #0
2	SW. INSTR./ TU-2 #1
3	SW. INSTR./ TU-12 #2
4	SW. INSTR./ TU-3 #0
5	SW. INSTR./ TU-12 #4
6	SW. INSTR./ TU-12 #5
7	SW. INSTR./ TU-3 #0
8	SW. INSTR./ TU-12 #7
9	SW. INSTR./ TU-12 #8
10	SW. INSTR./ TU-3 #0
11	SW. INSTR./ TU-12 #10
12	SW. INSTR./ TU-12 #11
13	SW. INSTR./ TU-3 #0
14	SW. INSTR./ TU-12 #13
15	SW. INSTR./ TU-12 #14
16	SW. INSTR./ TU-3 #0
17	SW. INSTR./ TU-12 #16
18	SW. INSTR./ TU-12 #17
19	SW. INSTR./ TU-3 #0
20	SW. INSTR./ TU-12 #19
21	SW. INSTR./ TU-12 #20
22	SW. INSTR./ TU-3 #0
23	SW. INSTR./ TU-2 #1
24	SW. INSTR./ TU-12 #23
25	SW. INSTR./ TU-3 #0
26	SW. INSTR./ TU-12 #25
27	SW. INSTR./ TU-12 #26
28	SW. INSTR./ TU-3 #0
29	SW. INSTR./ TU-12 #28
30	SW. INSTR./ TU-12 #29
31	SW. INSTR./ TU-3 #0
32	SW. INSTR./ TU-12 #31
33	SW. INSTR./ TU-12 #32
34	SW. INSTR./ TU-3 #0
35	SW. INSTR./ TU-12 #34
36	SW. INSTR./ TU-12 #35
37	SW. INSTR./ TU-3 #0
38	SW. INSTR./ TU-12 #37
39	SW. INSTR./ TU-12 #38
40	SW. INSTR./ TU-3 #0
41	SW. INSTR./ TU-12 #40
42	SW. INSTR./ TU-12 #41
43	SW. INSTR./ TU-3 #0
44	SW. INSTR./ TU-2 #1
45	SW. INSTR./ TU-12 #44
46	SW. INSTR./ TU-3 #0
47	SW. INSTR./ TU-12 #46
48	SW. INSTR./ TU-12 #47
49	SW. INSTR./ TU-3 #0
50	SW. INSTR./ TU-12 #49
51	SW. INSTR./ TU-12 #50
52	SW. INSTR./ TU-3 #0
53	SW. INSTR./ TU-12 #52
54	SW. INSTR./ TU-12 #53
55	SW. INSTR./ TU-3 #0
56	SW. INSTR./ TU-12 #55
57	SW. INSTR./ TU-12 #56
58	SW. INSTR./ TU-3 #0
59	SW. INSTR./ TU-12 #58
60	SW. INSTR./ TU-12 #59
61	SW. INSTR./ TU-3 #0
62	SW. INSTR./ TU-12 #61
63	SW. INSTR./ TU-12 #62

FIG. 8

SW.INSTR. = Switching Instruction

1
INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 93/00292

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: H04Q 11/04, H04Q 11/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: H04J, H04L, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

ORBIT: WPAT, USPM

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	US, A, 5197063 (YUKIO NAKANO ET AL), 23 March 1993 (23.03.93), column 3, line 23 - column 7, line 11; column 9, line 29 - column 11, line 38, figures 1-14 --	1-3
X	JP, A, 3-214891 (HITACHI LTD), 20 Sept 1991 (20.09.91), see the whole document --	1-3
P,A	GB, A, 2254754 (GPT LIMITED), 14 October 1992 (14.10.92), page 3, line 4 - page 4, line 29, figures 1-3 --	1-3

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

- * Special categories of cited documents:
- * "A" document defining the general state of the art which is not considered to be of particular relevance
- * "E" earlier document but published on or after the international filing date
- * "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- * "O" document referring to an oral disclosure, use, exhibition or other means
- * "P" document published prior to the international filing date but later than the priority date claimed

- * "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- * "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- * "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- * "&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

15 October 1993

19 -10- 1993

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Magnus Stiebe
Telephone No. +46 8 782 25 00

2
INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 93/00292

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4471479 (OSKAR G. WAAS), 11 Sept 1984 (11.09.84), see the whole document --	1-3
A	EP, A1, 0406191 (TELEFONAKTIEBOLAGET L M ERICSSON), 2 January 1991 (02.01.91), column 1, line 26 - column 2, line 18; column 3, line 4 - column 4, line 55; column 5, line 28 - line 38, figures 1,2 -- -----	1-3

INTERNATIONAL SEARCH REPORT
Information on patent family members

26/08/93

International application No.
PCT/FI 93/00292

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 5197063	23/03/93	JP-A- 3214891	20/09/91
JP-A- 3-214891	20/09/91	NONE	
GB-A- 2254754	14/10/92	NONE	
US-A- 4471479	11/09/84	DE-A- 3122230	23/12/82
		EP-A,B- 0066653	15/12/82
		SE-T3- 0066653	
EP-A1- 0406191	02/01/91	AU-B- 625583	16/07/92
		AU-A- 5950390	17/01/91
		CA-A- 2033981	27/12/90
		JP-T- 4500445	23/01/92
		SE-B,C- 464003	18/02/91
		SE-A- 8902309	27/12/90
		US-A- 5022026	04/06/91
		WO-A- 9100678	10/01/91

THIS PAGE BLANK (USPTO)

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☒ FADED TEXT OR DRAWING
- ☒ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☒ GRAY SCALE DOCUMENTS
- ☒ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.

THIS PAGE BLANK (USPTO)